Some like it healthy: demand for functional products in the Italian yogurt market

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Abstract: *Despite the significant interest shown by academics as to investigating the market of functional foods, little empirical research has used market data to infer on the characteristics of functional foods' consumers via demand analysis. Using a discrete choice (nested-logit) model and scanner data of yogurt purchases in the Italian market, this paper analyzes the demand for both conventional and functional yogurts assessing also the role of health-related demographics as shifters. The empirical results show that, in the category analyzed, while higher prices are still a deterrent for the success of some functional products, drinkable functional yogurts appear successfully differentiated, benefitting from a relatively low own-price elasticity of demand. The results suggest also that health-related consumers' characteristics play an important role in shifting the demand for yogurts (both conventional and functional), indicating that, consistently with previous findings, consumers aiming to improve (or maintain) their health status are more inclined to buy functional products than conventional ones.*

Key words: Functional foods, health-conscious consumers, nested-logit, yogurt. [JEL: D12; L66; Q13]

1. Introduction

Consumers' attention for nutraceutical products (featuring both *nutr*itional and pharm*aceutical* properties) has been growing. Among these, particularly significant is the expansion of the market for food products whose ingredients may provide additional health benefits besides that of nutrition, or functional foods. According to the European Commission's Concerted Action on Functional Food Science in Europe (FuFoSE), coordinated by the International Life Science Institute (ILSI) "*a food product can only be considered functional if together with the basic nutritional impact it has beneficial effects on one or more functions of the human organism thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases.*"[1] Several others definitions of functional foods exist[2, 3].

Food manufacturers who invest on functional products face challenges related to both the additional R&D[1] and marketing costs necessary to develop and market these products. The latter appears to be a problem particularly in Europe: the European Market for functional foods is sluggish if compared to larger markets such as Japan and the U.S., probably because European consumers are less inclined to believe in the fact that functional foods can provide additional health benefits, than consumers in other parts of the globe [6]. Nonetheless, functional foods can be a vehicle of healthy profits for those firms that are able to target the right consumers [7].

In light of these trends, a large body of literature has analyzed different dimensions of the functional foods phenomenon, mostly relying on survey data and *ad hoc* empirical models, providing valuable, although fragmented, information, but failing to provide a unified framework of analysis [3]. One finding, common to many studies, is that functional foods have the characteristics of credence goods for which beliefs and

[1] Unilever invested more than 50 million US$ to develop the functional yogurt Nestlé Lc1 and the proactive margarine Becel, amount that is considerably higher than the general estimated cost of developing a new food product (2 million US$)[4]. When firms produce functional food, it is also possible that they encounter diseconomies of scope, so that these may affect their overall profitability [5].

subjective information are crucial determinants of consumers' acceptance [8, 9]. For example, a series of interrelated studies using data from surveys of Finnish consumers repeated over time,[10-12] found that demographics play a weak role as predictors of the willingness to use functional foods, while psychographic characteristics such as the perceived reward and the necessity for such foods have a much stronger role.

As information asymmetry and uncertainty may be at the base of consumers' skepticism regarding the acceptance of these products [4, 9] a lack of transparency may translate into a lack of differentiation, resulting in lower than expected performances. Despite the fact that consumers have shown higher willingness to pay for food products containing functional components [13 – 15], and functional products are often sold at higher margins than conventional ones (up to 30-50% in certain large categories [4]) the higher prices may still be a hurdle for the acceptance of these products [16] .

Another defining aspect of the market for functional foods is that price and trust are not the only determinants of their acceptance, but that consumers' health status, lifestyle and health concerns play strong role in consumers' attitude towards them [17, 3]. For example, among Belgian consumers, believing in the health benefits of functional foods is the main positive determinant of their acceptance, although knowledge and presence of an ill family member outweigh the role of other socio-demographic variables (income included).[8] The same seems to be true also in cross-cultural contexts: besides marked cross-cultural differences, a sample of college/university students living in USA, Canada and France, health, showed that health-related benefits beliefs and credibility of information are the main positive determinant of the acceptance of functional products.[18] Other findings suggest that consumers have directly (or through closeness with some family member) experienced illnesses such as stress, hearth diseases, osteoporosis or symptoms such as lack of energy, are much more sensitive to specific health claims on food products oriented towards those specific conditions. [19]

The type of nutritional information that consumers look for varies depending upon the intrinsic health attributes of different product categories: consumers seem to pay more attention to health-claims on products which are already perceived as healthy [20]. This may indicate that functional products introduced in a certain category could be more easily accepted than others. Some evidence exists that product category perceived as healthy and/or with established prior beliefs with regard to their health properties (such as yogurt, cereals and juice), have a better chance to be seen as credible carriers of functional components [21, 22]

In light of the literature discussed above, this paper contributes to the understanding of the market of functional foods, by focusing on one case study (the Italian yogurt market) and using market data instead of survey data to deliver one of the first analyses of the demand for these products. Specifically, the objective of this paper is to evaluate whether the findings of the literature which uses stated preferences hold when actual market data and a revealed preference approach used. In other words, this study aims to provide a unified framework to evaluate the impact of both price and consumers' health related characteristics on the success of functional products, accounting for differences in preferences across conventional and functional products in the same product category. To achieve these objectives, this paper uses a scanner database of yogurt purchases in hypermarkets and supermarkets in Italy to estimate the demand for eleven yogurt sub-categories, seven conventional and four functional, via a discrete-choice (nested-logit) demand model, including health-related demographic characteristics as shifters.

The Italian yogurt market was chosen as a case study for two reasons. First, yogurt represents a category of healthy, probiotic[2] products *per se*, fact which may mitigate the credence component generally associated with functional foods.[3] Second, the largest yogurt manufacturers operating in this market (Danone,

[2] A probiotic component is defined as "*a viable microbial dietary supplement that beneficially affects the host through its effects in the intestinal tract"* [23].

[3] There is strong evidence that, among fresh dairy products, yogurts have beneficial effects in the treatment of different pathologies (such as tumors of the intestinal tract and pathologies connected with aging) as well as a strengthening effect of the immune system [24]; furthermore, all yogurts sold in the European market must contain live bacteria, granting them the title of probiotic foods. Also, since a food product, to be

Granarolo, Nestlé and Parmalat), have largely invested in the development and marketing of functional products, resulting in an overall growth rate of this segment of about 30% in the three-year period 2004-2006.[4]

The results show that, in the Italian yogurt market, different levels of differentiation exist among functional and conventional products, with drinkable, functional yogurts emerging as a successfully differentiated sub-category, suggesting that the credence component in this market may be more marked for the non-drinkable alternatives.

The results indicate also that, consistently with previous evidence, health-related consumers' characteristics have a major role in the impact of the success of functional products, suggesting that the diffusion of functional products in the Italian yogurt market increases with an increase of the number of health conscious individuals and with that of the population whose health stock is diminishing.

2. Diffusion of functional yogurts in the Italian market

Functional yogurts have been available in the Italian market since the late 1980's, starting with Parmalat's product line Kyr (whose formulation includes *Lactobacillus paracasei*), initially aiming to appeal to a niche of high-end consumers. The real turning moment for this market, took place with Danone's entry in the functional yogurts segment with the brands Activia and Actimel, which, thanks to strong communication and positioning strategies, were able to achieve large market penetration as well as an increase consumption frequency[27].

The market of functional yogurts in Italy is in strong expansion. Figure 1 shows the average weekly sales of both conventional and functional yogurts sold in hyper- and supermarkets in Italy during the thirty-six-month period January 2004-December 2006, along with market shares of functional yogurts (source: IRI Infoscan) [28]. Despite sales of both categories (conventional and functional) are clearly affected by seasonal variations in consumption, the overall emerging trend is that, while sales of conventional yogurts have not grown sensibly, those of functional yogurts have followed a clear upward trend. As the average sales of conventional yogurts have not dwindled, the uptrend of functional foods' sales indicates that new consumers are attracted to the yogurt market specifically by these products. Overall, in the three-year period considered, functional yogurts have increased their market shares, reaching a value as high as 30% during the pre-peak periods (March-April) in 2006.

Recent trends are exemplified by the annual average market shares reported in table 1. Drinkable yogurts have about three/fifths of the market, and seem destined to grow, gaining more than 3% of shares in the period 2004-2006. In terms of market shares, the second largest subcategory of functional yogurts is that of "other flavors" (in a range of 18-20% of the market), followed by fruit flavored functional yogurts (approximately 15%) and white (small and in decline). Table 1 includes also the market shares of Danone, the market leader in all the functional sub-categories considered. The success of Danone in the Italian market for functional yogurts is remarkable: in all the categories it shows large market shares, approaching in 2006 values of 85% for fruit and other flavors and surpassing this value for the white ones. Even in the sub-category of drinkable/functional products, where it faces the largest competition (primarily by Nestlé and Parmalat), Danone still obtains a market share of approximately 54%.

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defined as functional, should contain a component (not necessarily a nutrient) affecting one or more bodily functions in a targeted way so as to have positive effects on health[23] , the fact that yogurts are probiotic products may potentially be enough for the whole category to be classified as functional [25, 26].

[4] More details on the Italian yogurt market will be provided in the next section.

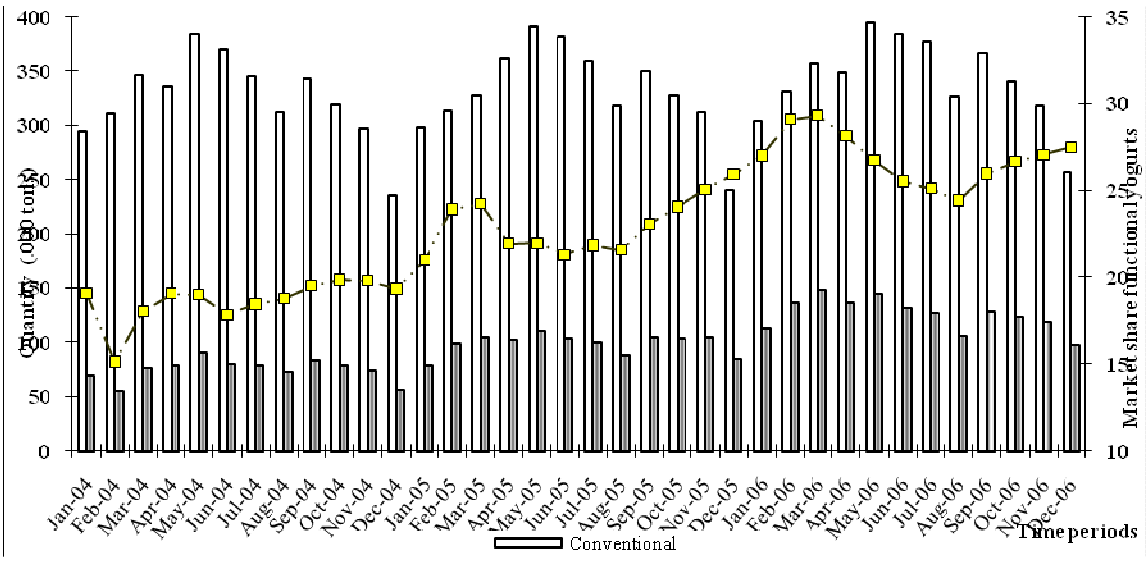

Figure 1. Average weekly sales of conventional and functional yogurts in Italy; market shares of functional yogurts: hyper- and super-markets (2004-2006). *Source*: author's elaboration on IRI Infoscan data.

Table 1. Average sub-category shares of functional yogurts and market shares of the market leader (Danone) (2004-2006).

Type of functional	Category shares			Danone's market share		
yogurt	2004	2005	2006	2004	2005	2006
White	7.55	6.48	6.22	74.58	84.46	85.34
Fruit	14.83	12.41	14.15	72.40	78.69	83.19
Other Flavors	19.42	20.86	18.30	79.18	86.03	84.10
Drinkable	58.20	60.25	61.32	53.63	53.56	54.29

Source: author's elaboration on IRI Infoscan data.

3. The model

Assume that a rational consumer i ($i=1,...,N$) maximizes her utility by choosing among J+1 product alternatives (j=0 indicating the outside option, which in this case would be that of not purchasing yogurt). The conditional indirect utility that she receives from purchasing one unit of product j can be represented as:

$$U_{ij}\left(\zeta_i, p_j, \mathbf{x}_j, \xi_j; \boldsymbol{\theta}\right) = -\alpha p_j + \mathbf{x}_j\boldsymbol{\beta} + \xi_j + \varepsilon_{ij}, \quad i=1,...,N,\ l=0,...,J \ ; (1)$$

where ζ_i indicates individual i's characteristics (both observed and unobserved); p_j is the per-unit price of product j; $\mathbf{x}_j$ is a (row) vector containing product's j observable attributes (fat content, flavor, presence of a functional attribute etc…); ξ_j indicates the unobserved product characteristics (unknown to the researcher, but not to the consumers) of alternative j, $\boldsymbol{\theta}=(\alpha,\boldsymbol{\beta})$ is a (column) vector of taste parameters (α representing consumers' marginal disutility of price, while $\boldsymbol{\beta}$ includes taste parameters associated with the products' physical attributes); and ε_{ij} is a random term capturing taste heterogeneity which is function of ζ_i.[5] The

[5] This representation is consistent with preference structures in which consumers choose products depending on their attributes [29].

assumptions made on the form of consumers' heterogeneity (ζ_i) are crucial in defining the kind of discrete choice model to use and it will be illustrated below. At this point of the exposition is however necessary to clarify that, throughout this section, any heterogeneity in preferences (and therefore ζ_i) will be assumed to be function of health–related attributes, *i.e*. that the resulting perception of the health content of a product is at the base of such heterogeneity. This has two implications: 1) that functional products will be perceived differently than conventional ones; and 2) that such differences may be function of health-related consumers' characteristics.

Going back to the general exposition of the model, consumer *i* will maximize her utility by buying one unit of the product which provides her with the highest satisfaction, conditionally on prices and product characteristics. Consequently, product *j* will be chosen if:

$$U_{ij}\left(\zeta_i, p_j, \mathbf{x}_j, \xi_j; \boldsymbol{\theta}\right) > U_{ik}\left(\zeta_i, p_k, \mathbf{x}_k, \xi_k; \boldsymbol{\theta}\right), \quad \text{for } j \neq k. \tag{2}$$

Let δ_j be the portion of utility from the consumption of good *j* which is common across consumers, usually defined as the mean utility of good *j*:

$$\delta_j = -\alpha p_j + \mathbf{x}_j \boldsymbol{\beta} + \xi_j, \tag{3}$$

which, for a given preferences' structure (i.e. for given α and $\boldsymbol{\beta}$) will depend exclusively on the characteristics of product *j*. From equation (3) it follows that the utility obtained by consumer *i* purchasing product *j* can be expressed as $U_{ij} = \delta_j + \varepsilon_{ij}$.

As mentioned above, different models results from different assumptions on the structure of the random term ε_{ij} . Under the assumption of ε_{ij} being distributed i.i.d. extreme-value, consumers taste is treated as homogenous, resulting in the simplest discrete choice model, the multinomial logit, which leads to heavily restricted substitution patterns. The assumption of ε_{ij} being i.i.d. type I extreme value, across products and consumers, leads to the Independence of Irrelevant Alternative (IIA) property which imposes the ratio of two odds to be independent on the characteristics of the other products, resulting in the cross price elasticity between two products being function only of one product's shares and prices. [30] The other extreme, is that of to model ε_{ij} as a combination of random and deterministic components, fully capturing consumers' heterogeneity [31, 32]. One can introduce consumers' heterogeneity in the model by interacting consumers' attributes with product characteristics, both observables (p_j and those contained in $\mathbf{x}_j$) and unobservables, so that $\varepsilon_{ij} = \sum_{j,l} \theta_{jl} z_{il} x_j + e_{ij}$, where z_{il} is the *l*-th characteristic of consumer *i* and e_{ij} is, again, an i.i.d extreme value random term [33, 34]. As both observable and unobservable consumers attributes enter the specification of ε_{ij} , the resulting taste parameters will embody a random component, from which the name of Random Coefficient (RC) model. The RC model is appealing as it includes consumers' heterogeneity in a random utility framework in a formal fashion; however, two hurdles exist in its implementation: 1) having access to detailed consumer's data becomes a necessity and; 2) the presence of the random components leads to a rather complex estimation algorithm. [35]

The assumption on ε_{ij} which will be adopted in this paper is that of assuming consumers' preferences being correlated among groups of products. This assumption results in substitution patterns being more flexible than those of the multinomial logit, but more restricted than those of the RC model for two reasons: 1) the structure of the groups is an *a priori* modeling choice and 2) the heterogeneity of consumers' preferences does not depend on continuous variables, but only on the grouping structure itself. As this model results in a tree-like preference structure, it is referred to as nested logit.

Assume that products are divided in H+1 mutually exclusive sets indicated with $D_h, h=0,...,H,$ where 0 indicates the outside good. In the context of this analysis, as consumers are assumed to group products according to their health-enhancing features, the set will be h= {0; F; C}, where F stands for functional, C for conventional and 0 indicates the outside good. ε_{ij} becomes:

$$\varepsilon_{ij} = \zeta_{ih} + (1-\sigma)\nu_{ij} \tag{4}$$

where ζ_{ih} is a random term whose value is common to all the products in a given group, meaning that any functional (conventional) product will provide the same level of utility to the i-th consumer (besides that coming from the mean utility); the parameter σ ($0<\sigma<1$) measures the degree of substitutability between products in the same group showing larger values when products inside each group are perceived as closer substitutes than products across groups; ν is, again an i.i.d. extreme value random term.

Using the fact that, if ν is distributed extreme value, then $[\zeta+(1-\sigma)\nu]$ is also a random variable distributed extreme value[36, 31], equation (4) can be reinterpreted as if capturing consumers' heterogeneity via the introduction of a random term for each group of products. In other words, if d_{jh} represents an indicator variable equal to 1 if $j \in D_h$, 0 otherwise, one has:

$$\varepsilon_{ij} = \zeta_{ih} + (1-\sigma)\nu_{ij} = \sum_h d_{jh}\zeta_{ih} + (1-\sigma)\nu_{ij}. \tag{5}$$

The expression for the conditional market share of product j in group h is modeled as $s_{j|h} = D_h^{-\sigma}\exp\left(\delta_j/(1-\sigma)\right)$, where $D_h = \sum_{k\in h}\exp\left(\delta_k/(1-\sigma)\right)$ [28]. Since the overall share of all the products in group h is $s_h = D_h^{(1-\sigma)}\left[\sum_h D_h^{(1-\sigma)}\right]^{-1}$, the unconditional market share of product j is:

$$s_j = \frac{\exp\left(\delta_j/(1-\sigma)\right)}{D_h^{\sigma}\sum_h D_h^{(1-\sigma)}}, \quad j=0,...,J;\ h=\{0;F;C\}. \tag{6}$$

Assuming that the mean utility of the outside option is equal to 0, the market share of the outside good will be $s_0 = \left[\sum_h D_h^{(1-\sigma)}\right]^{-1}$ which, combined with equation (3) and equation (6) gives the following estimable linear equation:

$$\ln\left(s_j\right) - \ln\left(s_0\right) = -\alpha p_j + \mathbf{x}_j\boldsymbol{\beta} + \sigma\ln(s_{j|h}) + \xi_j\,.^{6} \tag{7}$$

Equation (7) allows only product characteristics to enter the demand equation. One of the objectives of this analysis is that of providing insights on the role of health-related consumers' attributes in choosing a functional (vis-à-vis a conventional) yogurt: as data on such attributes are scant, the implementation of a RC model will be infeasible. What follows here is an illustration of an empirical model based on equation (7), for which theoretical rigor is sacrificed in favor of ease of implementation and feasibility. Let m be an index of the markets included in the analysis and l that of consumers' health related attributes. Using the

[6] Own- and cross-price eslasticities are obtained from the estimated parameters as:

$$\eta_{jk} = \begin{cases} \dfrac{\alpha}{1-\sigma}\,p_j\left(1-\sigma s_{j|h}-(1-\sigma)s_j\right) & \text{if } j=k; \\ \dfrac{\alpha}{1-\sigma}\,p_k\left(-\sigma s_{k|h}-(1-\sigma)s_k\right) & \text{if } j\neq k \text{ and } j,k\in h; \\ -\alpha p_k s_k & \text{otherwise.} \end{cases}$$

notation described previously, allowing for health related consumers attributes to enter equation (7) in a linear and additive fashion, and indicating the LHS of (7) as $y_{jm} = \ln(s_{jm}) - \ln(s_{0m})$ one has:

$$y_{jm} = -\alpha p_{jm} + \mathbf{x}_j \boldsymbol{\beta} + \sum_h d_{jh} \sum_l \gamma_l^h z_{ml} + \sigma \ln(s_{jm|h}) + e_{jm} \qquad (8)$$

where the z_{ml} s represent variables capturing health-related features of the population in market *m*, the γ_l^h s are the parameters associated with them, d_{jh} is the group indicator variable described previously and e_{jm} is an error term. All other notation is illustrated above.

One practical implication of this model is that it allows measuring the relative impact of a change in health related population characteristics on the demand for functional yogurts relative to that of conventional ones. In other terms the combination of parameters $\gamma_l^F - \gamma_l^C$ gives:

$$\gamma_l^F - \gamma_l^C = \left.\frac{\partial \ln(s_j / s_0)}{\partial z_l}\right|_{j \in F} - \left.\frac{\partial \ln(s_j / s_0)}{\partial z_l}\right|_{j \in C}, \qquad (9)$$

which, essentially, calculates the log of the odds-ratio of an increase in market share of functional yogurts compared to conventional ones'. In other words, the difference in the estimated parameters expressed in equation (9) captures the difference in the changes of market shares between *any* of the functional alternatives and *any* of the conventional ones for a marginal change of the health indicators. An example may clarify: consider the coefficients associated with an indicator of "healthy lifestyle", the percentage of population who does not smoke. Equation (9) showing positive sign would indicate that a growth in the non-smoking population increases the likelihood of observing a purchase of a functional yogurt more than that of observing a purchase of a conventional yogurt.

4. Data and Estimation

Equation (8) is estimated using primarily a scanner database provided by the Food Marketing Policy Center at the University of Connecticut and the Univeristà Cattolica del Sacro Cuore di Piacenza, Italy, supplied originally by Information Resources Incorporated (IRI).[7] The data used in the estimation include twenty-four monthly observations of yogurt sales (quantities and values) for the period January 2005 – December 2006 in hyper- and super-markets located in seventeen Italian IRI regional markets[8] to cover most of the national territory, for a total of 408 market combinations. Eleven products sub-categories are identified in the data using flavor (white, fruit and other flavors), fat content (skim and whole), drinkable versus non-drinkable, and the presence (or absence) of a functional attribute, as to obtain seven conventional and four functional sub-categories, for a total of 4,488 usable observations. Product characteristics are measured via indicator variables for fruit flavor, other flavors, whole, and the presence of a functional attribute.

The total size of the yogurt market is calculated assuming that every consumer in the market consumes one serving of yogurt daily,[9] which, following a similar analysis of the demand for yogurts in the Italian market, is assumed to be 125 grams[37]. Volume and value of sales are used to calculate prices in €/serving. The database contains also average volume per unit and a measure of market penetration (number of items per product per store). Summary statistics of the data used in the estimation are reported in table 2.

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[7] Special thanks go to Ronald W. Cotterill, director of the Food Marketing Policy Center and to Renato Pieri, director of the Dipartimento di Economia Agroalimentare, Piacenza for granting access to the data.

[8] All IRI regions are defined consistently with the political boundaries except "Piedmont and Val d'Aosta", "Basilicata and Calabria" and "Abruzzo and Molise".

[9] The implementation of discrete choice models requires the researcher to either estimate or to calculate the total market size for the good analyzed [31]. One of the usual practices is that of assuming the total market size as that resulting by each individual in the population consuming one suggested serving of the product per day. Market shares, including that of the outside option, can then be calculated.

In order to keep the analysis broad, four general indicators are chosen to capture health status and consumers' attitude towards health; the first two attributes, average age and percentage of population affected by chronic diseases, tend to capture the depletion of the stock of health capital[38], while percentage of population practicing sport and percentage of population being non smokers are used to capture attitudes toward a healthy lifestyle.[39] The demographic data used are annual regional averages reported by the Sistema Statistico Nazionle (SISTAN) through the Annuario Statistico Italiano, by the Istituto Nazionale di Statistica (ISTAT), years 2005 and 2006.[10] [40]

Table 2. Sample averages of the key variables used in the estimation

Product		Market shares			Price		*Volume*	*Items*
		Actual	*Unconditional*	*Conditional*	*€/Kg*	*€/serving*	*per unit*	*per store*
Conventional								
White	skim	0.0505	0.0050	0.0671	3.1720	0.3965	0.2923	2.3384
White	whole	0.0911	0.0091	0.1202	2.9899	0.3737	0.3164	2.5314
Fruit	skim	0.1343	0.0134	0.1898	3.6067	0.4508	0.3807	3.0454
Fruit	whole	0.3219	0.0321	0.4399	3.2074	0.4009	0.2884	2.3076
Flavor	skim	0.0194	0.0019	0.0261	4.3528	0.5441	0.2517	2.0137
Flavor	whole	0.0901	0.0090	0.1128	3.4727	0.4341	0.2271	1.8167
Drink		0.0303	0.0030	0.0442	3.6632	0.4579	0.2994	2.3951
Functional								
White		0.0156	0.0016	0.0756	4.8522	0.6065	0.2740	2.1920
Fruit		0.0327	0.0033	0.1580	5.0870	0.6359	0.2639	2.1112
Flavor		0.0469	0.0047	0.2340	5.0273	0.6284	0.2715	2.1718
Drink		0.1671	0.0166	0.5324	5.4999	0.6875	0.5146	4.1170

Source: author's elaboration on IRI Infoscan data.

Equation (8) contains two potentially endogenous variables, price and the log of conditional shares. In order to solve potential endogeneity issues, the model is estimated using a two-stage procedure: in the first stage, price per serving is instrumentalized by regressing it on all the exogenous variables included in equation (8) and some additional cost variables, namely: per-capita gross earning in retailing (regional, annual);[41] the industrial price of heating oil (national, monthly, €/hl);[42] and the commercial price of electricity at the source (regional, monthly, €/Mw).[43] Using the instrumentalized price, equation (8) is estimated via Generalized Method of Moments (GMM) using the unconditional and conditional store penetration shares (calculated using the number of items per store) as instruments for the log of conditional shares. Region specific fixed effect and monthly dummies are added to the regressions in both stages of the estimation process. The estimation was executed using STATA v. 10.

5. Results

The model appears to perform well: the estimated parameters are jointly significant at the 0.1% level; the R-squared is 0.9066; and, lastly, the result of an Hansen's *J*-test[44] shows that the overidentifying instrument used to control for the endogeneity of the log of conditional shares is orthogonal to the error terms. The results of the estimation of equation (8) and the relative tests as in equation (9) are described below.[11]

[10] The original data come from the annual survey "Aspetti della vita quotidiana" which was not conducted for the year 2004.

[11] The results of the first-stage equation to instrument for price per serving are excluded for brevity and are available upon request to the author.

5.1. Estimated parameters and own-price elasticities

The estimated parameters and related statistics are reported in table 3. The coefficient for price is negative (-0.05307) and significant at the 5% level; the estimated σ is positive and significant at the 0.1% level, its magnitude being 0.9602. The estimated coefficients associated with the indicators of fruit and other flavors appear positive and significant, while the functional attribute appear negative (due mainly to the fact that market shares of functional products are on average smaller than those of conventional products), while the indicator for low-fat yogurts (skim) is not statistically significant, indicating that flavors have a much stronger effect as shifters than fat content. For completeness, it is worth mentioning that the estimated parameter for volume per unit is positive and significant while that of number of items per store is also positive, but not significant, indicating that consumers seem more attracted by larger purchases and less influenced by the depth of distribution.

Table 3. Estimated parameters and related statistics; equation (8)

Variable	Estimate	Std. error	*t*-ratio
Price	-0.5307	0.1906	-2.7800
Ln($S_{j\|h}$)	0.9602	0.0184	52.2000
Fruit	0.0418	0.0188	2.2200
Other Flavors	0.0592	0.0212	2.8000
Skim	-0.0123	0.0098	-1.2600
Functional	-5.0295	0.4379	-11.4900
Volume per Unit	0.4967	0.1352	3.6700
Item per Store	0.0005	0.0005	0.9000
Age*Conv.	0.1565	0.0598	2.6200
Age*Funct.	0.1782	0.0610	2.9200
Chronic Dis*Conv.	-0.0043	0.0017	-2.5500
Chronic Dis*Funct	0.0078	0.0026	3.0100
Sport * Conv.	0.0027	0.0099	0.2700
Sport * Funct.	-0.0280	0.0109	-2.5700
Don't Smoke*Conv.	-0.0211	0.0066	-3.2100
Don't Smoke*Funct.	0.0173	0.0087	1.9900
Montly Dummies		YES	
Region Dummies		YES	
Constant	-8.0680	2.0428	-3.9500
Number of obs	4488		
R-squared	0.9066		
Wald $\chi^2_{(37)}$ =1.20*10^5	(p-value=0.0000)		
Hansen's J-stat $\chi^2_{(1)}$ = 1.22134 (p-value = 0.2691)			

The coefficients associated with the interaction of health-related demographic characteristics with conventional and functional yogurts' indicators are significant at the 5% level with the exception of the rate of population regularly practicing sport interacted with the conventional indicator which is not significant. The coefficients of the interaction of average age with the group indicators show both positive signs suggesting that, overall, Italian consumers increase their demand for yogurts as they grow older, perhaps seeing them as good alternatives to other dairy products for their easy digestibility or for their probiotic properties[25] The estimated coefficients of the percentage of population suffering from chronic conditions interacted with the conventional and functional indicators are both significant and show different signs, the former being negative (-0.0043) and approximately half of the size of the latter, which is instead positive (0.0078). A similar pattern emerges for the impact of the percentage of non-smoking population, although the magnitude of the estimated coefficients is not very different (- 0.0211 that of the interaction with the

conventional indicator, and 0.0173 that of the interaction with the functional indicator). These results indicate that, at least to some extent, health-related attributes impact the way consumers' discriminate between conventional and functional alternatives among the same product category, consistently with previous findings which suggest that health status has a role in impacting consumers' acceptance of functional foods. [18, 19, 8] The coefficients connected with practicing sport seems they show negative sign (-0.0280) when interacted with the functional indicator and positive (although not significant) when interacted with the conventional one. Despite it may appear going against the findings discussed above, as practicing sport regularly necessitates of a certain level of health, the findings are in line with those of the other variables, suggesting that healthier individuals tend to consumer less functional foods.

Before elaborating more on how consumers' health related attributes affect the likelihood of consuming functional versus conventional yogurts, an illustration of the estimated own-price elasticities for demand will follow as to understand the role of price on shaping the demand of functional yogurts in the Italian market. The estimated values are reported in table 4 along with summaries of the cross-price elasticities.[12]

The estimated own-price elasticities are all significant at the 0.1% level. Furthermore, they appear of reasonable magnitude when compared to other demand studies[13] that have focused on the Italian yogurt market and that have used data at different level of aggregation. [37, 45] A first pattern that emerges is that, for conventional yogurts, whole yogurts show lower price elasticities than skim ones, trend which is consistent across flavors (-4.942 for white skim versus -4.494 for white whole; -4.910 for fruit skim versus -3.079 for fruit whole; and -7.068 for other flavors skim and -5.156 of other flavors whole). A second pattern is that, among conventional alternatives, the demand for fruit yogurts appears less elastic than for other flavors, (drinkable ones included).

Table 4. Estimated own-price elasticities and summary of cross- price elasticities

Product	Own-price elasticity			Cross-price elasticities			
	Estimate	St. error	Wald-stat	Inside the nests		Outside the nests	
				Min	Max	Min	Max
Conventional							
White skim	-4.942	1.1807	17.52	0.182	2.263	0.000	0.006
White whole	-4.404	1.0491	17.62	0.182	2.263	0.000	0.006
Fruit skim	-4.910	1.1645	17.62	0.182	2.263	0.000	0.006
Fruit whole	-3.079	0.7130	18.65	0.182	1.098	0.000	0.006
Flavor skim	-7.068	1.6922	17.45	0.260	2.263	0.000	0.006
Flavor whole	-5.156	1.2289	17.60	0.182	2.263	0.000	0.006
Drink	-5.842	1.3974	17.48	0.182	2.263	0.000	0.006
Functional							
White	-7.495	1.7896	17.54	1.287	4.689	0.001	0.007
Fruit	-7.186	1.7072	17.72	0.587	4.689	0.001	0.007
Flavor	-6.491	1.5335	17.92	0.587	4.689	0.001	0.007
Drink	-4.472	1.0184	19.28	0.587	1.883	0.001	0.007

Note: For the Wald test the critical value of $\chi^2_{(1)}$ for a 0.1% significance level is 10.83

[12] As the pattern of cross-price elasticity obtained using a nested-logit is still heavily restricted, cross-price elasticities are not extensively discussed. However, more detailed analyses of cross-price elasticities between functional and conventional products in the Italian yogurt market are available. [45]

[13] At the sub-category-level the magnitudes of the elasticities of demand for yogurt are as high as -2.633 for children's yogurts (category which is not present in the data used for this analysis) and as low as -0.799 for drinkable yogurts. [37] At the brand-level instead the values are much larger,[45] going from values as high as -10.42 for Granarolo's skim white conventional yogurts to the lowest value of -1.4 for Danone's drinkable functional yogurts.

Two patterns emerge by comparing the own-price elasticities of conventional and functional yogurts. The own-price elasticities for white and fruit flavored yogurts across conventional and functional alternatives appear proportional to the difference in prices across the products. This suggests that both white and fruit functional yogurts do not appear to the eyes of consumers differentiated enough to justify lower price elasticities (i.e. consumers do not show higher willingness to pay for such functional products). For the "other flavors" alternative instead, the own price elasticity of demand for the functional alternative (-6.491) is smaller than that of the conventional/skim one (-7.068) but larger than whole (-5.156), hinting to some extent of successful differentiation. On the other hand, the demand for drinkable, functional yogurts, appears more inelastic than that for conventional one (-5.842 conventional vs. -4.472 functional); as the price of functional yogurts being on 40 % higher than the conventional counterpart (see the average values in table 2), this result suggests that drinkable functional yogurts appear as highly differentiated to the consumers' eyes.

In sum, the estimated own-price elasticities highlight that drinkable functional yogurts are successful as to attract consumers with lower price sensitivity, while a mix of price-responsiveness emerges for the non-drinkable ones. This trend is not surprising as the manufacturers operating in the Italian yogurt market have invested heavily in the development and marketing of drinkable-functional yogurts (see table 2).

5.2. Impact of health on the odds of buying functional yogurts.

The results of the tests performed as in equation (9), are reported in table 5, along with the odds ratio of an increase in market shares of functional products versus that of conventional ones. All the estimated log-odds are small, but statistically different than zero, indicating that, overall, as consumers' health worsens, or as consumers embrace healthier lifestyles, their acceptance of functional yogurts increases resulting in a shift of preferences from conventional to functional alternatives.

The results of the tests indicate that, on average, as the stock of health gets depleted (aging, presence of chronic diseases) the likelihood of consuming functional products increases. For every year that the population ages the odds of observing an increase in consumption of functional yogurts is 2% larger than that of observing an increase in consumption of conventional ones. A smaller (in the order of 1%), but still positive effect can be observed for the percentage of individuals affected by chronic diseases, indicating that such individuals may attempt to contrast the depletion of their stock of health by engaging in consumption of functional foods. These results are supported by the positive effect of the percentage of non-smoking population on the odds of buying functional yogurts versus conventional ones. A 1% increase in the percentage of the non-smoking population is associated with an increase in 3% of such odds, indicating that as population adopts a more health conscious behavior, the market penetration of functional yogurts increases. Also, as one can interpret practicing sport as an outcome of being in good health, the negative estimated log odds for the percentage of population practicing sport on a regular basis, supports the finding that, as health worsens, consumers tend to prefer functional yogurts to conventional ones.

Although corroborating *a priori* expectations, the validity of the results described above may be open to questioning on both a conceptual (related with the choice of the variables used)[14] and an empirical (due to the nature of the data used)[15] ground. Some robustness checks were therefore performed and equation (8) re-estimated using the health indicators individually and in pairs (to capture the impact of stock of health

[14] From a conceptual standpoint, it has been pointed out that health-related lifestyles attributes are impacted by individuals' health status and vice versa, fact which ultimately affect consumers' behavior[39].

[15] Despite the correlation coefficients among the demographic indicators are not large ($\rho_{(age;\ chronic\ disease)}$=0.32; $\rho_{(age;\ sport)}$=0.38; $\rho_{(age;\ non\text{-}smoking)}$=-0.41; $\rho_{(sport;\ chronic\ disease)}$=-0.35; $\rho_{(sport;\ non\text{-}smoking)}$=-0.08; and $\rho_{(non\text{-}smoking;\ chronic\ disease)}$= -0.47), given the annual, regional nature of the data, the risk of multicollinearity among these variables should not be excluded a priori.

and lifestyle variables, respectively).[16] Table 6 presents the results of the tests as in equation (9) conducted on the six sets of estimates from the alternative specifications of equation (8).

Table 5. Impact of consumers' health-related characteristics on the likelihood of success of functional yogurts

Variable	Test value	Std. error	*t*-ratio	Odds-ratio
Average age	0.0217	0.0071	3.0800	1.0220
% Pop. chronic diseases	0.0120	0.0025	4.8200	1.0121
% Pop. practicing sport	-0.0307	0.0038	-8.0200	0.9697
% Pop. non-smoking	0.0385	0.0054	7.1900	1.0392

Table 6. Impact of consumers' health-related characteristics on the likelihood of success of functional yogurts: alternative model specifications

Variable	Test value	Std. error	*t*-ratio	Odds-ratio
Single Indicators				
Average age	0.0132	0.0052	2.5400	1.0133
% Pop. chronic diseases	0.0217	0.0022	9.7600	1.0219
% Pop. practicing sport	-0.0270	0.0028	-9.4800	0.9734
% Pop. non-smoking	0.0231	0.0053	4.3100	1.0233
Stock variables only				
Average age	-0.0055	0.0054	-1.0300	0.9945
% Pop. chronic diseases	0.0222	0.0023	9.7400	1.0225
Lifestyle variables only				
% Pop. practicing sport	-0.0323	0.0029	-11.0700	0.9682
% Pop. non-smoking	0.0417	0.0054	7.7700	1.0425

In all the alternative specifications of the demand model which include only one health indicator, the estimated log-odds of buying functional yogurts versus conventional ones are consistent in sign with those of the full specification, presenting only slight variations in magnitude, suggesting that the finding are overall robust. Even for the specifications including pairs of variables to represent, respectively stock of health and health-related lifestyles, the results seem overall robust, with the only exception being the test for the log-odds of average age which indicates that, under this specification, age changes appear not to impact the likelihood of success of functional foods.

6. Conclusions

The success and expansion of functional products have triggered a large body of research, whose findings present a thorough, although fragmented representation of the market of these products and of their consumers'. However, as the majority of the existing studies investigating functional foods relies on survey

[16] The full sets of results of the alternative specifications of equation (8), which are omitted for brevity, are available upon request to the author.

data and stated preference methods, not much is known on the actual demand for these products and the role that consumers' characteristics may have on it.

This paper has focused on a specific case study, the Italian yogurt market, to present a first set of econometric estimates of the demand for conventional and functional sub-categories inside a product category, while assessing the role of health-related population attributes as demand shifters. A discrete-choice nested-logit demand model was used, to treat consumers taste as heterogeneous across groups of products (functional and conventional). Data restriction did not allow for a theoretically consistent representation of consumers' taste heterogeneity which could have been obtained by using a more complex methodology (*i.e.* a random coefficient model).

Results show that, even inside a single product category, functional products present diverse levels of differentiation: in the Italian market only drinkable yogurts seem to be perceived as effectively differentiated from their conventional counterpart. This result suggest that, while price may still be a hurdle in the acceptance of certain functional products, successful differentiation is possible as it can be observed for drinkable yogurts, which appear to attract a larger consumers' base made mostly of less price sensitive individuals. The results corroborate those of other research, as the role of health-related population attributes appears to be such that, as the stock of health depletes and consumers embrace healthier lifestyles, consumers tend to be more prone to purchase functional yogurts, increasing the likelihood of success of these products.

Two broad suggestions for future research come from the results illustrated and the limitations of this analysis. First, as the results have shown that, even inside one product category with some intrinsic health properties such as yogurt, only some functional products appear to be successfully differentiated, future research on functional foods should consider identifying the source of a successful differentiation strategy within a product category instead of focusing on broader ones. Second, much is left to be unraveled regarding the interaction of functional foods' consumption and consumers' health; the robustness of the results of this analysis, obtained via a simple modeling strategy not fully consistent with theory, opens the way to future research on disentangling the complex relationship between consumption of functional products and health status, which is still a rather unexplored area.

Reference

1. Diplock, A. T., Aggett, P. J., Ashwell, M., Bornet, F., Fern, E. B., & Roberfroid, M. B. (1999). Scientific concepts of functional foods in Europe: Consensus document. *British Journal of Nutrition* 81(supplement 1), S1–S27.
2. American Dietetic Association (1999). Position of the American Dietetic Association - functional foods. *Journal of the American Dietetic Association* 99(8):127-128.
3. Siró, I., Kápolna, E., Kápolna, B., and Lugasi, A. (2008). Functional foods. Product development marketing and consumer acceptance, a review. *Appetite* 51:456–467.
4. Menrad , K. (2003). Market and marketing of functional food in Europe. *Journal of Food Engineering* 56: 181–188.
5. Herath, D., Cranfield, J.,Henson, S., and Sparling, D. (2008). Firm, market and regulatory factors influencing innovation and commercialization in Canada's functional food and nutraceutical sector. *Agribusiness: An International Journal* 24 (2):207–230.
6. Bech-Larsen, T. and Scholderer, J. (2007). Functional foods in Europe: consumer research, market experiences and regulatory aspects. *Trends in Food Science & Technology* 18: 231-234.
7. Heasman, M., and Mellentin, J. (2001). The functional foods revolution: Healthy people, healthy profits? Earthscan. 240 pages.
8. Verbeke W. (2005a). Consumer acceptance of functional foods: socio-demographic, cognitive and attitudinal determinants. *Food Quality and Preference* **16:** 45–57.
9. Verbeke W. (2005b). Agriculture and the food industry in the information age. *European Review of Agricultural Economics* 32(3): 347-368.

10. Urala, N. and Lähteenmäki, L., (2007) Consumers' changing attitudes towards functional foods. *Food Quality and Preference* **18:**1–12.
11. Urala, N. and Lähteenmäki, L. (2003). Reasons behind consumers' functional food choices. *Nutrition and Food Science* **33**: 148–158.
12. Urala, N. and Lähteenmäki, L. (2004). Attitudes behind consumers' willingness to use functional foods. *Food Quality and Preference* **15:** 793–803
13. West, G. E., Gendron, C., Larue, B., and Lambert., R. (2002). Consumers' valuation of functional properties of foods: results from a Canada-wide Survey. *Canadian Journal of Agricultural Economics* 50: 541–558.
14. Laure, B., West, G. E., Gendron, C., and Lambert., R. (2004). Consumer response to functional foods produced by conventional, organic, or genetic manipulation. *Agribusiness: An International Journal* 20(2): 155–166.
15. Markosyan, A., Wahl, T. I., and McCluskey., J. J. (2007). Functional foods in the marketplace: willingness to pay for apples enriched with antioxidants. Selected paper presented at the American Agricultural Economics Association Annual Meeting, Portland, OR, July 29-August 1, 2007.
16. Childs, N.M. and Poryzees, G.H. (1997). Foods that help prevent disease: consumer attitudes and public policy implications. *Journal of Consumer Marketing* 14: 433–447
17. Hilliam, M. (1998). The market for functional foods. *International Dairy Journal* 8:349–353.
18. Labrecque, J.A., Doyon, M., Bellavance, F., and Kolodinsky, J. (2007). Acceptance of functional foods: a comparison of French, American, and French Canadian consumers. *Canadian Journal of Agricultural Economics* 54: 647–661.
19. Van Kleef, E., Van Trijp, H.C.M. and Luning, P. (2005). Functional foods: Health claim-food product compatibility and the impact of health claim framing on consumer evaluation. *Appetite* **44**: 299–308.
20. Balasubramanian, S. K., and Cole, C. (2002). Consumers' search and use of nutrition information: the challenge and promise of the nutrition labeling and education act. *Journal of Marketing* 66:112–127.
21. Poulsen, J. B. (1999). Danish consumers' attitudes towards functional foods. Working Paper No. 62. Aarhus, Denmark: MAPP, 49 pages.
22. Roe, B., Levy, A. S., and Derby, B. M. (1999). The impact of health claims on consumer search and product evaluation outcomes: Results from FDA experimental data. Journal of Public Policy and Marketing 18: 89–105.

23. Roberfroid, M.B. (2000). Concepts and strategy of functional food science: the European perspective. *American Journal of Clinical Nutrition* 71(suppl): 1660S–1664S.
24. Zubillaga, M., Weill, R. Postaire, E. Bioch, C. G. Caro, R. J. and Bioch B. (2001). Effect of probiotics and functional foods and their use in different diseases. *Nutrition Research* 21: 569–579.
25. Lourens-Hattingh, A. and Viljoen, B. C. (2001). Yogurt as probiotic carrier food. *International Dairy Journal* 11: 1–17.
26. Roberfroid, M.B. (2007). Probiotics: The concept revisited. *The Journal of Nutrition* 137(suppl): 830S–837S.
27. Torrazza, V. (2008). I mercati Grocery - Yogurt e salute generano un binomio di successo. *Markup* 166 (April).
28. Information Resource Inc. (IRI) - Infoscan Database. 2004-2006. Retail Scanner Data on Yogurt Purchases – 17 Italian Regions (Hyper and Super). Milano, Italy.
29. Lancaster, K. J. (1996). A new approach to consumer theory. *Journal of Political Economy* 74: 132-157.
30. McFadden, D. (1984). Econometric analysis of qualitative response models. In Z. Griliches & M. D. Intriligator (eds.), Handbook of Econometrics, vol. 2:1395-1457. New York: North Holland.
31. Berry, S. (1994). Estimating discrete choice models of product differentiation. *The RAND Journal of Economics* 25:242–262
32. Berry, S., Levinsohn, J., and Pakes, A. (1995). Automobile prices in market equilibrium. *Econometrica* 63:841–890.
33. Nevo, A. (2001). Measuring market power in the ready-to-eat cereal industry. Econometrica 69: 307–342.
34. Berry, S., Levinsohn, J., and Pakes, A., (2004). Differentiated products demand systems from a combination of micro and macro data: The new car market. *Journal of Political Economy* 112:68–104

35. Nevo, A. (2000). A Practitioner's guide to the estimation of random coefficients logit models of demand. *Journal of Economics & Management Strategy* 9(4): 513–548
36. Cardell, S. (1997). Variance component structure for extreme-value and logistic distributions with applications to model of heterogeneity. *Econometric Theory* 13(2): 185-213.
37. Di Giacomo, M. (2008). GMM estimation of a structural demand model for yogurt and the effects of the introduction of new brands. *Empirical Economics* 34:537–565.
38. Grossman, M., (1972). On the concept of health capital and the demand for health. *Journal of Political Economy* 80(2): 223–255.
39. Contoyannis P., and Jones A. M. (2004). Socio-economic status, health and lifestyle. *Journal of Health Economics* 23: 965–995.
40. Istituto Nazionale di Statistica: Annuario Statistico Italiano (2005-2006).
41. Osservatorio Italiano del Commercio (2005; 2006). Statistiche Economiche: Redditi da lavoro dipendente. Available at www.sviluppoeconomico.gov.it. Accessed July 7th, 2008.
42. Ministero dello Sviluppo Economico, D. G. E. R. M. Statistiche dell'Energia (2005-2006). Available at http://www.sviluppoeconomico.gov.it/ Accessed 07/07/2008.
43. Gestore Mercato Elettrico Italiano (2005; 2006) Daily Historical Data on electricity prices and production. Available at: www.mercatoelettrico.org. Accessed July 7th, 2008.
44. Hansen L. P. (1982). Large sample properties of generalized method of moments estimators. *Econometrica* 50: 1029–1054.
45. Bonanno, A. (2009). Functional foods as differentiated products. Food Marketing Policy Center Research Report No. 113, University of Connecticut, Storrs. 36 pages.